NASA Aeronautics University Design Challenge:
Design of an Urban Package Delivery Aircraft
(Technical Paper)

Societal Impacts of Urban Air Mobility
(STS Paper)

A Thesis Prospectus Submitted to the
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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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STS Prospectus

Introduction

Urban Air Mobility, or UAM, is a rapidly growing field of transportation in which personal autonomous aircraft move passengers and cargo by air in urban settings. Advances in autonomous flight, avionics, electric and hybrid-electric propulsion, and detect-and-avoid systems have allowed this idea to gain significant traction in recent years. Many of the leading names in aviation, including Boeing, Airbus, and Bell, have invested billions of dollars in the development of vertical takeoff and landing aircraft for this new market. Uber also plans to introduce an aircraft for urban air-taxis by 2023 (Butterworth-Hayes & Stevenson, 2019). Industry revenue is expected to top $318 billion from 2020-2040 according to a study conducted by Nexa Advisors (Zart, 2019). UAM promises to fix many of the problems surrounding congested urban environments. These overcrowded environments pose many problems for society such as increased pollution and traffic that lead to lost time and have negative social effects. While UAM helps to alleviate these issues, it also risks creating new harmful impacts of its own. The positive and negative impacts of urban air mobility on the human experience must be considered and weighed as the system is under development. Economic, environmental, and social factors must all be considered when determining how to integrate this new type of transportation system in order to increase the efficacy of this new technology.

Technical Topic

For my capstone, I am enrolled in the aircraft design course. Our team is working to complete a conceptual design for urban package delivery as outlined in the NASA Aeronautics

University Design Challenge. Our team is tasked with designing an aircraft that is able to autonomously deliver a five-pound package within a ten-mile radius in an urban environment. The aircraft must be able to complete two trips, completely autonomously, and must do so in a safe manner. NASA outlines the design goal as designing "a safe, reliable, profitable, low-noise autonomous unmanned aircraft system (UAS), including the ground systems, to deliver small packages via air transport to designated landing platforms."("NASA Aeronautics University Design Challenge", 2019) Safety, the business case, and performance are given the most weight in the contest accounting for 25% of the total scoring. Operations and noise considerations hold a 15% and 10% weight, respectively. Any aircraft layout and all power systems are available, but the team has chosen to focus on using a fully electric power system and is exploring concepts of tail-sitter, tilt-wing, and lift/cruise configurations. The aircraft must be able to work with the proposed FAA unmanned aircraft system traffic management (UTM) system which is still in development. This requires onboard communications, identification, and positioning systems. Detect and avoid (DAA) systems will also be required in order for the aircraft to autonomously prevent collisions with uncooperative manned and unmanned vehicles that are not identified by the UTM system. With regards to vehicle performance, a landing platform that is 50 feet long and 25 feet wide will be available. The aircraft must be able to climb to 400 feet and descend from that altitude each within a mile. Wind up to 20 knots and air densities up to 8000 feet must be considered. A complete technical report will be written by the entire team per the competition requirements and will also act as the technical report for this thesis project. This technical topic relates closely to the STS topic on urban air mobility as it also focuses on a network of aircraft flying within an urban environment, albeit on a smaller scale.

STS Framework

The STS theories of co-production of science and social order and social construction of technology (SCOT) will be used as frameworks to analyze the effects of urban air mobility on society. Co-production of science and social order is a theoretical perspective developed by a number of STS scholars including Sheila Jasanoff, Steve Shapin, Simon Schaffer, Bruno Latour, and Ian Hacking. It proposes that societies' creation of new scientific objects produces new societies around them. In a sense, technology and society co-produce each other. Sheila Jasanoff wrote, "Co-production is shorthand for the proposition that the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we chose to live in it."("Co-production (society)", 2019) The co-production of science and social order frames a viewpoint for how the development of UAM transportation systems will likely alter how society operates as well as how societal factors can influence the design of such systems. Additionally, SCOT proposes that technological innovation in greatly influenced by the social context that promotes, or fails to promote, the given innovation. As framed by co-production, we see that UAM will have a great impact on society but society itself greatly influences the development and success of this system. Overall, the development of an urban air mobility system will have substantial impacts on the society in which we live. Day to day activity of society will possibly see both positive and negative changes and continue to evolve with the progression of an air mobile system. Specifically, UAM has the potential to greatly alter transportation methods around the world and have revolutionary effects within an urban setting. These effects will not only span transportation methods, but may also alter economic, environmental, and social aspects of society.

Plan for Thesis

For the STS portion of my thesis, I will continue to conduct research on the idea of urban air mobility having societal impacts, shaping the world around us in both positive and negative ways. As companies in the aviation industry continue to make developments in the technology as well as techniques for implementation, this information will be analyzed and considered. Developments of regulations for the implementation of this type of system will also be analyzed as the FAA is actively working to construct the framework in which this system will operate. Understanding these regulations posed by the FAA will be almost as crucial as urban air mobility itself as the system will be governed and constrained by these regulations. Societal effects will therefore result from the regulations as well as the system itself. With regards to economic effects, the focus will be on how time will be saved through this form of transportation. Faster routes by air travel as well as reduced congestion on roadways will reduce the amount of time spent on traveling. Autonomous flight also enables passengers to use their commute time more productively as the time and energy spent focusing on operating a vehicle can be used for other activities. This development will likely lead to economic improvements. Analysis of environmental effects will focus on how pollution will be reduced through a UAM system. A majority of concepts use electric vertical take-off and landing aircraft for the system, leading to a reduction in air pollution created by burning fossil fuels in internal combustion engines. This increased demand for electric aircraft may lead to an increase of extraction of materials to create electric batteries which creates a significant amount of ground pollution. Additionally, the electric energy required by these vehicles may still be produced by fossil fuel methods. These tradeoffs will be analyzed and discussed in further detail in the thesis. Noise pollution must also be considered as frequent aircraft flying overhead at low altitudes will have effects. Although

noise produced from electric aircraft is significantly less than that produced from aircraft powered by turbine jet engines, electric aircraft present a new issue with consistent high pitched "buzzing" noise over a heavily populated area in contrast to short lived loud instances. It is possible that the noise pollution discussed or vehicles frequently flying overhead could have harmful psychological effects on the population. Social impacts, such as the effect of buzzing noises on mental well-being, will also be explored. This research aims to explore answers to a number of questions. Will society accept this autonomous form of travel or will humans always want a physical pilot with air travel? Will frequent overhead flying objects have effects on our mental health and the beehive buzzing noise pollution lead to unwanted effects? Will this new system of transportation lead to positive environmental effects with the use of electric aircraft and reduction of congested polluting highways? Information will be gathered from online article databases that frequently publish articles in the field of aviation such as the Journal of Aviation/Aerospace Education and Research. The American Institute of Aeronautics and Astronautics (AIAA) database, ScienceDirect, and the UVA library will be used.

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